

Original Article

Incidence and mortality of liver cancer in China, 2010

Kuang-Rong Wei¹, Xia Yu¹, Rong-Shou Zheng², Xia-Biao Peng³, Si-Wei Zhang², Ming-Fang Ji¹, Zhi-Heng Liang¹, Zhi-Xiong Ou¹ and Wan-Qing Chen²

Abstract

Liver cancer is a common malignant tumor in China and a major health concern. We aimed to estimate the liver cancer incidence and mortality in China in 2010 using liver cancer data from some Chinese cancer registries and provide reference for liver cancer prevention and treatment. We collected and evaluated the incidence and mortality data of liver cancer in 2010 from 145 cancer registries, which were included in the 2013 Chinese Cancer Registry Annual Report, calculated crude, standardized, and truncated incidences and mortalities, and estimated new liver cancer cases and deaths from liver cancer throughout China and in different regions in 2010 from Chinese practical population. The estimates of new liver cancer cases and deaths were 358,840 and 312,432, respectively, in China in 2010. The crude incidence, age-standardized rate by Chinese standard population (ASR China), and age-standardized rate by world standard population (ASR world) were 27.29/100,000, 21.35/100,000, and 20.87/100,000, respectively; the crude, ASR China, and ASR world mortalities were 23.76/100,000, 18.43/100,000, and 18.04/100,000, respectively. The incidence and mortality were the highest in western regions, higher in rural areas than in urban areas, and higher in males than in females. The age-specific incidence and mortality of liver cancer showed a rapid increase from age 30 and peaked at age 80–84 or 85+. Our results indicated that the 2010 incidence and mortality of liver cancer in China, especially in undeveloped rural areas and western regions, were among high levels worldwide. The strategy for liver cancer prevention and treatment should be strengthened.

Key words Liver cancer, incidence, mortality, China

Primary liver cancer is a common malignant tumor worldwide and severely threatens health. According to GLOBOCAN 2012, the estimated age-standardized rates (ASR) of liver cancer incidence and mortality by world standard population (ASR world) in 2012 were 10.1/100,000 and 9.5/100,000, respectively, which ranked the fifth and third highest cancer incidence and mortality and accounted for 5.6% of all new cancer cases and 9.1% of all cancer deaths worldwide. Moreover, the ASR of liver cancer incidence and mortality by Chinese standard population (ASR China) in 2012 were 22.3/100,000 and 21.4/100,000, respectively, which ranked the second and third

highest cancer incidence and mortality and accounted for 12.9% of all new cancer cases and 17.4% of all cancer deaths in China in 2012^[1]. The incidence and mortality of liver cancer in recent years remained high worldwide^[1–3]. In China, the third causes-of-death survey showed that the liver cancer mortality increased by 68.41% in males and by 48.39% in females compared with the data from the first survey^[4,5], indicating the importance of liver cancer prevention and treatment. However, the estimates of liver cancer incidence and mortality in China were only available from GLOBOCAN 2012, which only involved the data of a few Chinese cancer registries (who reported cancer data to the “Cancer Incidence in Five Continents” project) and the all death-causes surveys in China^[1–3], and three causes-of-death surveys in China^[4–9]. Currently, the liver cancer incidence and mortality in China have not been estimated according to the data from cancer registries covering a large population. Thus, in China, we collected the incidence and mortality data of liver cancer in 2010 from 145 cancer registries to estimate the new cases and deaths of liver cancer across the country and in different regions to provide reference for liver cancer prevention and treatment.

Authors' Affiliations: ¹Cancer Institute, Zhongshan Municipal People's Hospital, Zhongshan, Guangdong 528400, P. R. China; ²National Central Cancer Registry, National Cancer Center, Beijing 100021, P. R. China; ³Digestive Internal Department, Zhongshan Municipal People's Hospital, Zhongshan, Guangdong 528400, P. R. China.

Corresponding Author: Wan-Qing Chen, National Central Cancer Registry, National Cancer Center, Pan-Jia-Yuan South Lane 17, Chaoyang District, Beijing 100021, P. R. China. Email: chenwq@cicams.ac.cn.

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Data and Methods

Data resources

The incident and death data of liver cancer in 2010 were acquired from cancer registries that were included in the 2013 Chinese Cancer Registry Annual Report with qualified data as required by the National Central Cancer Registry. The criteria for data quality were as follows: the percentage of cases morphologically verified (MV%) was higher than 66%, the percentage of death certificate-only cases (DCO%) was lower than 15%, and the mortality/incidence (M/I) ratio was between 0.6 and 0.8. The registries were stratified into grades A, B, C, and D according to the above criteria for data quality. Among all registries, grades A and B registries were included in the annual report, and grade C registries, with only individual indices failed to reach the criteria of grade B, were also included; grade D registries were excluded. The 145 qualified registries were located in 28 provinces, autonomous regions, and municipalities directly under the central government: 63 in urban areas and 82 in rural areas.

The population data came from the Bureaus of Statistics or Public Security at cancer registration areas. The 145 registries covered 158,403,248 people (80,355,188 males and 78,048,060 females) and accounted for 11.79% of the national population at the end of 2010: 92,433,739 of them in urban areas accounted for 58.35% of the population covered by the 145 registries; 65,969,509 in rural areas accounted for 41.65%.

Statistical analyses

All liver cancer data coded as C22 in the tenth version of the International Classification of Diseases (ICD-10) were analyzed. Incident and death cases, proportions, and crude, standardized, accumulated, truncated, and age-specific incidences and mortalities were calculated with the methods recommended by the National Cancer Registration Manual^[10]. ASR China and ASR world were calculated by using the fifth Chinese National Census of 2000 and Segi's world population as the population standards.

According to the geographic divisions released by the National Bureau of Statistics, cancer registration areas were divided into eastern, middle, and western regions as well as seven administrative regions. The above indices were calculated by region and sex stratifications. Age-specific estimates of new cases and deaths at each stratum were obtained by multiplying the age-specific incidence and mortality with the age-specific population at each stratum from the 2010 population census. The nationwide estimates of new cases and deaths were obtained by pooling calculations^[11].

Results

Data quality

The MV%, DCO%, M/I ratio, and the proportion of diagnosis of unknown basis (UB%) of liver cancer in 2010 were 37.64%, 5.28%, 0.90, and 0.97 in the 145 registries, 41.81%, 4.97%, 0.90, and

1.27 in urban areas, and 32.91%, 5.63%, 0.90, and 0.62 in rural areas, respectively. Higher data quality was obtained in urban areas compared with rural areas and in middle regions compared with eastern and western regions (Table 1).

Estimate of liver cancer incidence

The estimate of new liver cancer cases was 358,840, which accounted for 11.60% of all new cancer cases and ranked the fourth most common cancer in China in 2010. The crude, ASR China, and ASR world incidences were 27.29/100,000, 21.35/100,000, and 20.87/100,000, respectively. A total of 268,757 new liver cancer cases were estimated to occur in males, which accounted for 14.87% of all new cancer cases and ranked the third most common cancer in Chinese males in 2010. The crude, ASR China, and ASR world incidences in males were 39.94/100,000, 32.21/100,000, and 31.38/100,000, respectively. A total of 90,083 new cases were estimated to occur in females, which accounted for 7.01% of all new cancer cases and ranked the fifth most common cancer in Chinese females in 2010. The crude, ASR China, and ASR world incidences in females were 14.03/100,000, 10.41/100,000, and 10.30/100,000, respectively (Table 2). Males had a higher liver cancer incidence compared with females. The number of new cases in males was 2.93, 3.03, and 2.98 times of those in females in urban areas, rural areas, and nationwide, respectively.

Age-specific incidence

In 2010, the age-specific incidence of liver cancer in China was low before age 30, rapidly increased after age 30, and peaked at age 80–84 in males and age 85+ in females (Figure 1). The age-specific incidence was remarkably higher in males than in females. Among different regions, the age-specific incidences were similar only with slight difference in its peak age; the incidence in males in urban areas, middle regions, and western regions peaked at age 85+.

Incidence difference between regions

The estimate of new liver cancer cases in urban areas in 2010 was 166,166, which accounted for 9.78% of all new cancer cases and ranked the fifth most common cancer in urban areas. The crude, ASR China, and ASR world incidences in urban areas were 25.07/100,000, 18.27/100,000, and 17.94/100,000, respectively. The estimate of new liver cancer cases in rural areas in 2010 was 192,674, which accounted for 13.83% of all new cancer cases and ranked the third most common cancer in rural areas. The crude, ASR China, and ASR world incidences in rural areas were 29.55/100,000, 24.74/100,000, and 24.15/100,000, respectively (Table 2). The incidence was higher in rural areas compared with urban areas; the crude, ASR China, and ASR world incidences in rural areas were 1.18, 1.35, and 1.35 times of those in urban areas.

The incidence was the highest in western regions, lower in middle regions, and the lowest in eastern regions, but the differences were small, especially between middle and eastern regions (Table

Table 1. Data quality of liver cancer in China in 2010

Area	Sex	M/I	MV%	DCO%	UB%
All	Both sexes	0.90	37.64	5.28	0.97
	Male	0.89	37.71	5.16	0.93
	Female	0.94	37.45	5.62	1.06
Urban areas	Both sexes	0.90	41.81	4.97	1.27
	Male	0.88	41.84	4.71	1.20
	Female	0.97	41.70	5.73	1.47
Rural areas	Both sexes	0.90	32.91	5.63	0.62
	Male	0.90	32.98	5.68	0.63
	Female	0.92	32.70	5.50	0.60
Eastern regions	Both sexes	0.93	36.54	4.66	0.99
	Male	0.91	36.66	4.57	0.97
	Female	1.00	36.17	4.94	1.04
Middle regions	Both sexes	0.86	42.10	5.94	0.78
	Male	0.86	42.65	5.87	0.70
	Female	0.85	40.64	6.13	0.97
Western regions	Both sexes	0.81	35.01	7.56	1.25
	Male	0.80	34.14	7.21	1.21
	Female	0.84	37.81	8.70	1.38

M/I, mortality/incidence ratio; MV%, the percentage of cases morphologically verified; DCO%, the percentage of death certificate-only cases; UB%, the proportion of diagnosis of unknown basis.

Table 2. Liver cancer incidence in China in 2010

Area	Sex	Total (cases)	Crude rate (1/100,000)	Proportion (%)	ASR China (1/100,000)	ASR world (1/100,000)	Cumulative rate (%)	T-ASR (1/100,000)	Rank
All	Both	358,840	27.29	11.60	21.35	20.87	2.41	40.05	4
	Male	268,757	39.94	14.87	32.21	31.38	3.59	62.74	3
	Female	90,083	14.03	7.01	10.41	10.30	1.20	16.54	5
Urban areas	Both	166,166	25.07	9.78	18.27	17.94	2.08	32.94	5
	Male	123,924	36.52	12.70	27.69	27.09	3.10	52.58	3
	Female	42,242	13.06	5.84	8.80	8.74	1.02	12.60	5
Rural areas	Both	192,674	29.55	13.83	24.74	24.15	2.79	47.83	3
	Male	144,833	43.40	17.40	37.21	36.22	4.17	73.88	3
	Female	47,841	15.03	8.52	12.20	12.05	1.41	20.87	5
Eastern regions	Both	134,699	24.49	10.48	18.92	18.48	2.13	36.51	4
	Male	101,655	36.11	13.93	28.84	28.06	3.21	58.00	3
	Female	33,044	12.31	5.95	8.93	8.85	1.03	14.25	6
Middle regions	Both	112,641	26.66	11.18	20.85	20.46	2.39	38.28	4
	Male	82,099	38.08	14.10	30.57	29.99	3.48	58.66	3
	Female	30,542	14.76	7.18	11.12	10.94	1.28	17.33	5
Western regions	Both	111,500	32.56	13.93	25.99	25.34	2.87	48.21	3
	Male	85,003	48.32	17.13	39.66	38.46	4.32	75.71	2
	Female	26,497	15.91	8.71	12.04	11.97	1.37	19.37	5

ASR China, age-standardized rate by Chinese standard population; ASR world, age-standardized rate by Segi's world standard population; T-ASR, truncated age-standardized rate.

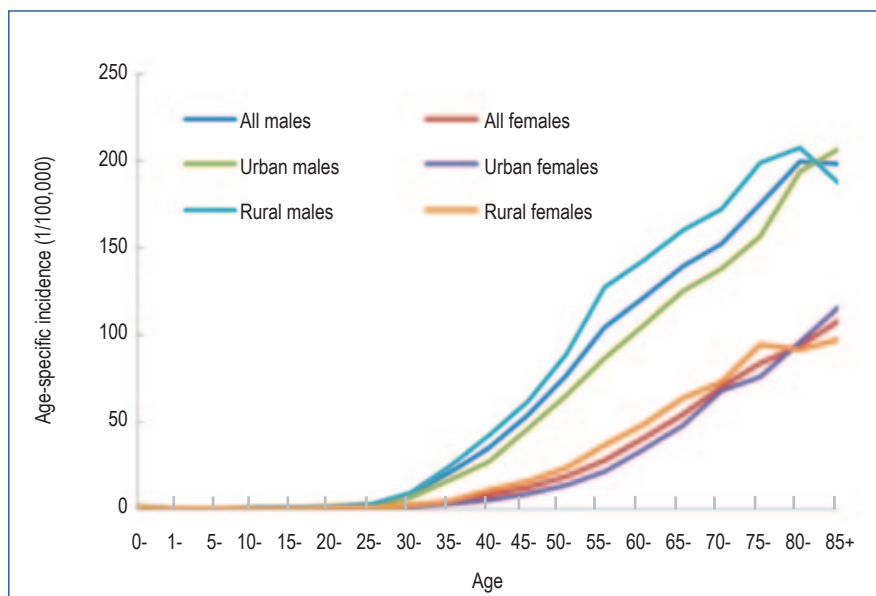


Figure 1. Age-specific incidence of liver cancer in China in 2010. In 2010, the age-specific incidence of liver cancer in China was low before age 30, rapidly increased after age 30, and peaked at age 80–84 in males and age 85+ in females. The age-specific incidence in males was remarkably higher than that in females. Among different regions, the age-specific incidences were similar, only with slight difference in the peak age; the incidence in males in urban areas peaked at age 85+.

2). Difference existed in its incidence with sex and geographic stratifications among the seven administrative regions. The incidence in males was the highest in South China followed by Northeast, Southwest, East, Central, Northwest, and North China, whereas the incidence in females was the highest in Northeast China followed by Southwest, Central, Northwest, East, South, and North China. In urban areas, the incidence was the highest in South China in males and in Central China in females, and was the lowest in North China in both sexes. In rural areas, the incidence was the highest in Northeast China in males and in Southwest China in females, and was the lowest in North China in both sexes. Generally, the incidences in the seven administrative regions were similar, especially the incidences in females in urban areas.

Estimate of liver cancer mortality

Liver cancer deaths were estimated at 312,432, which accounted for 15.97% of all cancer deaths and ranked the second most common cause of cancer death in China in 2010. The crude, ASR China, and ASR world mortalities were 23.76/100,000, 18.43/100,000, and 18.04/100,000, respectively. An estimate of 231,950 liver cancer deaths occurred in males, which accounted for 18.49% of all cancer deaths and ranked the second most common cause of cancer death in Chinese males in 2010. The crude, ASR China, and ASR world mortalities in males were 34.47/100,000, 27.69/100,000, and 27.04/100,000, respectively. An estimate of 80,482 liver cancer deaths occurred in females, which accounted for 11.46% of all cancer deaths and ranked the third most common cause of cancer death in Chinese females in 2010. The crude, ASR China, and ASR world mortalities in females were 12.54/100,000, 9.15/100,000, and 9.05/100,000, respectively (Table 3). The mortality was higher in males than in females. The number of liver cancer deaths in males

was 2.87, 2.97, and 2.88 times of that in females in urban areas, rural areas, and the whole country, respectively.

Age-specific mortality

In 2010, the age-specific mortality of liver cancer in China was similar to its age-specific incidence; it was low before age 30, rapidly increased after age 30, and peaked at age 85+ (Figure 2). The age-specific mortality was higher in males than in females. Among different regions, the age-specific mortalities were similar, only with slight difference in the peak age; its mortalities in rural areas, eastern regions, and western regions peaked at age 80–84.

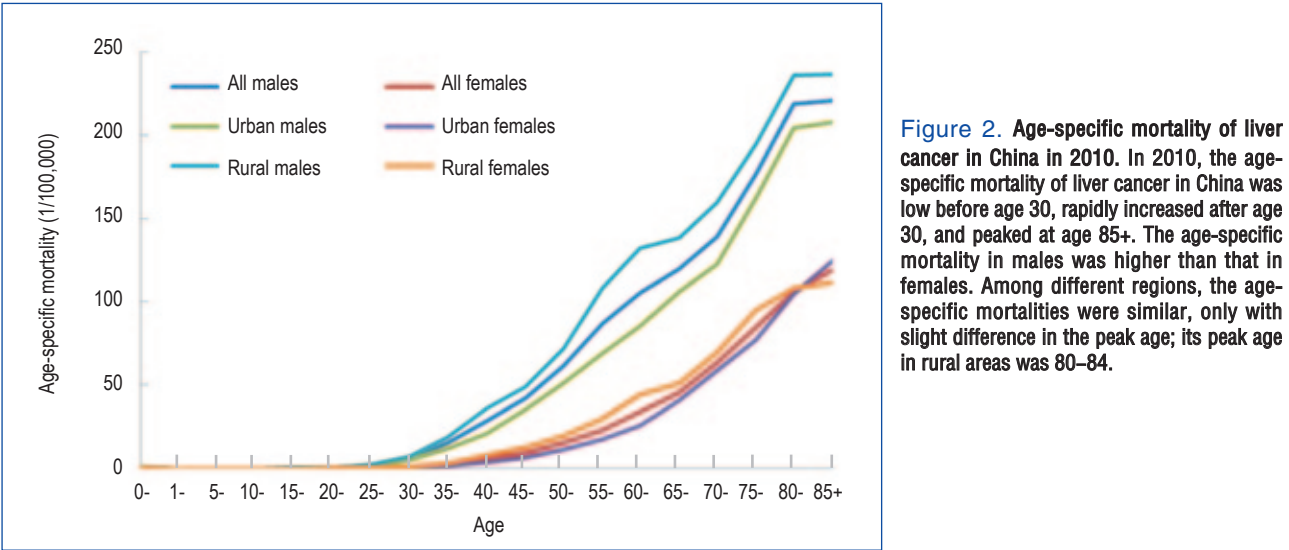
Mortality difference between regions

Liver cancer deaths in urban areas were estimated at 142,388, which accounted for 13.76% of all cancer deaths and ranked the second most common cause of cancer death in urban areas in 2010. The crude, ASR China, and ASR world mortalities in urban areas were 21.48/100,000, 15.46/100,000, and 15.16/100,000, respectively. Liver cancer deaths in rural areas were estimated at 170,044, which accounted for 18.45% of all cancer deaths and ranked the second most common cause of cancer death in rural areas in 2010. The crude, ASR China, and ASR world mortalities in rural areas were 26.08/100,000, 21.75/100,000, and 21.32/100,000, respectively (Table 3). The mortality was higher in rural areas than in urban areas. The crude, ASR China, and ASR world mortalities in rural areas were 1.21, 1.41, and 1.41 times of those in urban areas, respectively.

The geographic distribution of liver cancer mortality was similar to that of its incidence: both were the highest in western regions, lower in middle regions, and the lowest in eastern regions, with only small differences. Among the seven administrative regions, the mortalities

Table 3. Liver cancer mortality in China in 2010									
Area	Sex	Total (cases)	Crude rate (1/100,000)	Proportion (%)	ASR China (1/100,000)	ASR world (1/100,000)	Cumulative rate (%)	T-ASR (1/100,000)	Rank
ALL	Both	312,432	23.76	15.97	18.43	18.04	2.05	32.98	2
	Male	231,950	34.47	18.49	27.69	27.04	3.05	51.65	2
	Female	80,482	12.54	11.46	9.15	9.05	1.02	13.62	3
Urban areas	Both	142,388	21.48	13.76	15.46	15.16	1.72	26.06	2
	Male	104,689	30.86	16.03	23.26	22.72	2.56	41.56	2
	Female	37,699	11.65	9.88	7.67	7.61	0.85	10.01	3
Rural areas	Both	170,044	26.08	18.45	21.75	21.32	2.43	40.64	2
	Male	127,261	38.14	21.18	32.69	32.00	3.64	62.90	2
	Female	42,783	13.44	13.34	10.81	10.69	1.22	17.65	3
Eastern regions	Both	124,872	22.71	15.27	17.38	17.02	1.95	31.86	2
	Male	92,453	32.85	17.95	26.13	25.52	2.91	50.31	2
	Female	32,419	12.08	10.71	8.62	8.53	0.97	12.74	3
Middle regions	Both	95,997	22.72	15.62	17.58	17.26	1.95	30.32	2
	Male	70,456	32.68	17.88	26.14	25.60	2.86	47.11	2
	Female	25,541	12.34	11.58	9.09	9.00	1.03	13.04	3
Western regions	Both	91,563	26.74	17.46	21.26	20.77	2.32	38.17	2
	Male	69,041	39.25	20.00	32.15	31.31	3.49	59.41	2
	Female	22,522	13.53	12.56	10.19	10.09	1.11	15.90	3

Abbreviations as in Table 2.



in males were the highest in South China followed by Northeast, Southwest, East, Central, Northwest, and North China, whereas the mortalities in females were the highest in Northeast China followed by Southwest, Central, East, South, Northwest, and North China. In urban areas, the mortality was the highest in South China in males and in Central China in females, and was the lowest in Northwest China in both sexes. In rural areas, the mortality was the highest in Northeast China in males and in Southwest China in females, and was the lowest in North China in both sexes.

Discussion

Liver cancer is prevalent in underdeveloped countries, and 83% of liver cancer cases occur in underdeveloped countries, including 50% in China. According to GLOBOCAN 2012, the ASR world incidence and mortality of liver cancer in 2012 were 10.1/100,000 and 9.5/100,000 in the world, 12.0/100,000 and 11.5/100,000 in underdeveloped countries, 5.4/100,000 and 4.6/100,000 in developed countries, and 13.3/100,000 and 12.6/100,000 in Asia, respectively. The areas with the highest incidences and mortalities were in turn East Asia (ASR world, 20.9/100,000 and 19.6/100,000), Southeast Asia (14.2/100,000 and 13.6/100,000), North Africa (12.3/100,000 and 11.8/100,000), West Africa (12.1/100,000 and 11.5/100,000), and Melanesia (10.9/100,000 and 10.5/100,000). The countries with the highest incidences and mortalities were in turn Mongolia (78.1/100,000 and 70.3/100,000), Laos (52.6/100,000 and 50.9/100,000), Zambia (25.8/100,000 and 24.1/100,000), Vietnam (25.6/100,000 and 23.7/100,000), and Egypt (24.6/100,000 and 24.5/100,000)^[1]. Compared with the data from GLOBOCAN 2012, both the 2010 incidence and mortality of liver cancer in China were at high levels in the world. The rates in China in 2010 equaled the rates in East Asia, which were the highest in the world, and were 2 times of the worldwide averages, 4 times greater than the averages in developed countries, and 1.5 times greater than the averages in Asia and underdeveloped countries, but slightly lower than the rates in China estimated by GLOBOCAN 2012. The incidence in China in 2010 was close to those in Cambodia and Guinea, and the mortality in China was close to those in Guinea and Sierra Leone, both ranked the ninth in the world^[1].

The incidence and mortality of liver cancer in 2010 in China estimated by this study were similar to those of 32 registries in 2003–2007^[12], 56 registries in 2008^[13], and 72 registries in 2009^[14]. The mortality of liver cancer was lower than those of the death-causes surveys in 1990–1992 and 2004–2005, but higher than that in 1973–1975^[4-9]. The incidence and mortality of liver cancer in this study were higher in rural areas than in urban areas, which was consistent with the results in the literatures, but its M/I ratio was slightly higher than those in the second and third death-causes surveys in China^[4,5,8,9], lower than those of 32 registries in 2003–2007^[12] and 56 registries in 2008^[13], similar to that of 72 registries in 2009^[14]. The difference in incidences between urban and rural areas is mainly related to pathogenic factors of liver cancer, such as viral hepatitis, alcohol consumption, aflatoxin, obesity, diabetes, diet habits, and water pollution, whereas the difference in mortalities between urban and rural areas is also related to the conditions of local health care and economics^[15-18].

The first and second causes-of-death surveys in China revealed the geographic distribution features of liver cancer. It is prevalent in the Southeast Coast regions, such as Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi, and some regions in Northeast China, such as Heilongjiang, and rare in the Yungui Plateaus and East China, such as Beijing and Tianjin. High prevalence areas could

be adjacent to low prevalence areas, and the mortality of liver cancer in Southeast and Northeast China increases with the increase of longitude and latitude degrees^[6-9]. The third causes-of-death survey showed that the crude mortality was the highest in eastern regions, lower in middle regions, and the lowest in western regions. The ASR China mortality in rural areas was the highest in middle regions, lower in eastern regions, and the lowest in western regions, whereas the ASR China mortality in urban areas was similar in middle and western regions, and the lowest in eastern regions^[4,5]. In the present study, the crude and ASR China incidences and mortalities were the highest in western regions, lower in middle regions, and the lowest in eastern regions, which were inconsistent with the results of the third causes-of-death survey. This discrepancy may be due to the differences in the geographic distribution of survey sampling regions and cancer registries. In general, the differences in incidence and mortality between eastern, middle, and western regions were minimal, which were consistent with previous studies^[4,5]. In addition, the present study showed that the incidence and mortality of liver cancer were the highest in South China in males and in Northeast China in females, and were the lowest in North China, which were consistent with previous studies that revealed high prevalence in the Southeast Coast regions and some regions in Northeast China^[4-9].

In the present study, the incidence and mortality of liver cancer were higher in males than in females, which was consistent with previous studies with differences only in the male/female ratio^[1-9]. The higher risk of liver cancer in males compared with that in females might relate to the differences in the risk factor exposure or susceptibility to the risk factors, e.g., the proportions with alcoholism and HBV infections were higher in males than in females^[18]. The present study also showed that the age-specific incidence and mortality of liver cancer were low before age 30, rapidly increased after age 30, and peaked at age 80 or 85+, which were basically consistent with previous studies with only mild differences in the peak age^[1-9,19,20]. The age-specific mortality of liver cancer peaked at age 70–79 in the first and second causes-of-death surveys^[4] and at age 75 in Guangxi in 2004–2005^[20], and both the incidence and mortality peaked at age 60–64 in Qidong in 1972–2011^[21].

Although the MV% of liver cancer in the 145 registries in this study was slightly higher than that (34.10%) in the 2012 Chinese Cancer Registry Annual Report^[11], higher than that (25.28%) in the 2003–2007 cancer incidence and mortality in China^[12], and obviously higher than that (13.37%) in Qidong in 1972–2011^[21], it was obviously lower than that of all cancers (67.11%) in China in 2010^[11] and that of liver cancer in the “Cancer Incidence in Five Continents” report, volume 9, only equaled that of the registries listed as grade C (which with the worst data quality in the “Cancer Incidence in Five Continents” report, volume 9)^[22], and substantially lower than those in North America and some European countries in the “Cancer Incidence in Five Continents” report, volume 10^[23]. Moreover, the DCO% of liver cancer in this study was higher than that of all cancers (2.99%) in the 145 cancer registries in 2010^[11], indicating that the data quality of liver cancer in the 145 registries in this study, especially for the data

of rural areas, needs to be improved.

In conclusion, although the data quality of the present registries needs to be improved, our results show that 2010 incidence and mortality of liver cancer in China were at high levels worldwide, which were basically consistent with previous Chinese cancer registration data^[12-14] but lower than the results of the second and third causes-of-death surveys in China^[4,5,8,9]. The incidence and mortality were higher in males than in females, higher in rural areas than in urban areas, the highest in South China in males and in Northeast China in females, and the lowest in North China, with mild differences between eastern, middle, and western regions, which were basically consistent with previous studies^[1-9]. In addition, the age-specific incidence and

mortality in this study were also consistent with the rates in previous reports^[1-9,19,20].

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